Should California Reconsider Its Legal Drinking Age?

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Abstract

The recent call by 120 American college presidents for reassessment of the legal drinking age of 21 occurs as earlier studies prove to be increasingly limited and outdated. This study tests drinking age effects during the 1975-2005 period using Incidence Rate Ratio analysis of fatal traffic accident and violent death trends among persons ages 16-17, 18-20, and 21-24, as states with lower drinking ages at the time later raised their age limits to 21. Corresponding trends among ages 25-44 and in states that maintained constant drinking ages of 21 were used as control series. The 10 states that maintained "graduated drinking ages" of 18 for beer and/or wine displayed significantly lower violent death incidences among young people than did states with drinking ages for all alcoholic beverages of 18, 19, 20, or 21. This secondary data analysis suggests that California could reduce violent deaths, especially from homicides and motor vehicles, among 18-20-year-olds by approximately 9%, with similar benefits for 16-17- and 21-24-year-olds, if the legal drinking age for beer and wine was reduced to 18 and a controlled system of low-alcohol bars was initiated.

Keywords: drinking age, teen, alcohol, public policy

Introduction

Alternating assertions of progress and setbacks in preventing "underage drinking" (the use of alcohol by persons under age 21) threaten to become a permanent fixture of health and social policy discussion in California and the United States. From 1999 through 2006, around 128,000 Californians under age 21, two thirds of them aged 18-20, were arrested for possession of alcohol. Yet, among California drivers under age 21, the population-adjusted rate of fatal crashes involving driving while intoxicated (DWI) rose by 25% from 1999 to 2006, along with increases of 66% for age 21-24, 25% for age 25-44, and 42% for age 45-64; only drivers age 65 and older showed a decrease (FARS, 2008).

Overall, fatal DWI crashes in California bottomed at 1,184 (24.2% of all fatal crashes) in 1999, but since have risen to 1,667 (27.5%) in 2006. Alcohol poisoning deaths also have risen substantially among all ages in California since 1999, and arrests of both youths and adults for DWI and drunkenness remained unchanged (Center for Health Statistics, 2007; Criminal Justice Statistics Center, 2008). Binge drinking levels remain high among Americans in general, with 56.6 million estimated to have "binged" (consumed five or more alcoholic drinks on the same occasion at least once in the preceding 30 days) in 2006, up 23% since 1999 (SAMHSA, 2007). By internationally comparable measures such as overdose fatalities, the United States suffers by far the highest level of alcohol and drug mortality in the 22 Western nations, with only Finland showing higher levels of alcohol-related deaths (WHO, 2008). American policies toward alcohol do not appear as effective as those in peer nations.

In August of 2008, an organization of 120 college presidents proposed the "Amethyst Initiative" to examine reducing the legal drinking age from 21 to 18 nationwide (Choose Responsibility, 2008). Their goals (remarkably similar to those advanced in the 1930s by groups seeking to repeal alcohol Prohibition) are to provide safer legal settings for alcohol use and to reduce binge drinking, driving under the

influence, and alcohol poisoning stemming from students' clandestine illegal drinking. Their proposal has been strongly criticized by Mothers Against Drunk Driving and other groups as promoting underaged drinking.

California has maintained a legal drinking age of 21 for all alcoholic beverages since 1933 (NIDA, 1988). The state did not join the few that adopted lower legal drinking ages after the repeal of Prohibition or the majority of states that lowered drinking ages, mostly to 18, in the early 1970s. By the end of 1975, California was one of only 12 "21 states" that kept drinking ages of 21 for all alcoholic beverages. That year, 20 states had drinking ages of 18 for all beverages (here called "18 states"), seven had drinking ages of 19 or 20 for all beverages, 11 had "graduated drinking ages" of 18 for beer or wine and 21 for distilled spirits (liquor), and Illinois had a drinking age of 19 for beer and wine only. Over the next 15 years, all 39 states with lower drinking ages raised them to 21, many under pressure from Congress's National Minimum Drinking Age Act of 1984 to withhold 10% of highway funds from states with lower minimum ages for purchase and public possession of alcoholic beverages. By the end of 1990, all states had drinking ages of 21. Table 1 (see Appendix A) shows these 39 states by 1975 drinking age type and the dates when each state raised their age limit to 21.

The changes in motor vehicle fatalities, especially nighttime ones likely to involve drinking among 18-20-year-olds, as states first lowered and then raised their drinking ages, have been exhaustively analyzed (Wagenaar & Toomey, 2002). However, by today's standards, past studies suffer methodological and statistical flaws. Nearly all employ data that are now more than 20 years old and thus measure transition, not equilibrium, effects of raised drinking ages. Nearly all used supposedly unaffected control series consisting of age groups (typically 21-24) just older than those disenfranchised by raised drinking ages, a questionable choice given later studies suggesting that just-older ages may have been negatively affected (Asch & Levy, 1987; Dee & Evans, 2001). Few studies assessed deaths other than traffic fatalities. Researchers

also were hampered by short postlaw comparison periods, especially since most states adopted fairly lengthy transition periods that complicated assignment of data to one drinking age level.

However, the most serious flaw in previous research may be the failure to separately assess different types of drinking ages. Graduated drinking ages of 18 for beer and/or unfortified wine and 21 for hard liquor had fostered separate systems of low-alcohol"3.2 bars", serving under-21 drinkers in 10 states and the District of Columbia. These states (Colorado, Kansas, Maryland, Mississippi, Ohio, Oklahoma, North Carolina, South Carolina, South Dakota, and Virginia) and DC are diverse both in population size and geographical location. The safety effects of this type of "graduated drinking age" on the fatality of young people and the use of a graduated drinking age as a model for addressing "underage drinking" issues in California and elsewhere are examined here.

Alcohol abuse has long been recognized as a significant factor in all forms of violent (external) mortality (see Haberman and Baden, 1978), including motor vehicle accidents (especially those occurring at night), other accidents, suicides, and homicides. The study hypothesis is direct: if a drinking age of 21 saves lives compared to a drinking age of 18, we would expect the most affected age groups (18-20) to suffer higher incidence of the types of death most related to alcohol consumption when legally allowed to drink, and a lower incidence when denied legal drinking privileges by means of raising the drinking age. We would thus expect that a drinking age of 21 would reduce violent death incidence among 18-20 year-olds compared to a drinking age of 18.

Method

Description of the data
Drinking age changes were assessed by conducting secondary analyses of several data sets that serve as indices of alcohol-related mortality. Three fatal motor vehicle crash involvement measures (all crashes, nighttime

crashes occurring from 8pm to 3:59am, and daytime crashes) and five categories of violent death (motor vehicle deaths, other unintentional deaths, suicides, homicides, and all violent deaths) were examined for the 31-year, 1975-2005 period. The U.S. Highway Traffic Safety Administration's Fatality Analysis Reporting System provides details on motor vehicle accidents involving at least one fatality on public roadways, including the state, year, and time of day of each crash and the age of each driver involved through its interactive website for 1994-2005 and Traffic Safety CD-Rom for 1975-1994 (FARS, 2008). Included in this analysis were all fatal crashes involving drivers ages 16 through 44 by driver age, state, and year and time of day of crash obtained from these files' menus.

The National Center for Injury Prevention and Control provides the state, year, external cause of death, age of decedent, and corresponding populations for the years 1981-2005 through the NCIPC's website (NCIPC, 2008) and electronic mortality detail files for 1975-1995. Included are deaths from motor vehicle accidents (coded 295-306, International Classification of Diseases group codes, 10th revision); deaths from all other accidents (293-294, 307-329); suicide (330-337); homicide (338-346); and all violent causes (293-353). Deaths among ages 16-44 in the above causal categories by age, state, and year of death for the 1975-2005 period extracted from the file menus were included in this analysis.

Analysis
Analyses of the outcome measures of interest, violent deaths and driver involvements in fatal crashes, were conducted. Driver involvements in fatal crashes and violent fatalities by state, year, and age group were divided by corresponding populations to produce crude Incidence Rates for four age groups: 16-17, 18-20, and 21-24 as the test ages and 25-44 as the control series. The crude Incidence Rate (IR) was the number of cases (driver involvements and deaths in this study) occurring per a specified number of persons in a specified time period (per 100,000 population per year in this study) during the study period. The Incidence Rate Ratios (IRR),

the ratio of one crude IR to another, was used here to factor out state-level confounding influences other than drinking ages on driver involvement and fatality trends within each state. The crude IRs by state, year, and driver involvement or fatality category for the three youngest age groups were converted into IRRs by expressing each as a ratio to the corresponding crude IRs for ages 25-44. An IRR of 0.65 for motor vehicle fatalities for 16-year-olds in Colorado in 1980 means that the IR of 16-year-olds killed in motor vehicle crashes was 65% of the IR of Coloradans ages 25-44 killed in motor vehicle crashes in 1980.

To adjust for regional and national variables other than drinking ages that influence driver and fatality trends by age and year (such as gasoline prices, vehicle safety standards, and weather), the IRRs were converted into Adjusted IRRs, a measure intended to adjust for such confounders (see Hoffman et al, 2008). The IRRs for each of the test age groups for each driver and fatality category in the 39 test states that formerly had drinking ages of less than 21 were expressed as Adjusted IRRs relative to the corresponding mean IRRs of the 12 control states that maintained constant drinking ages of 21 throughout the 1975-2005 period. These "21 states" (Arkansas, California, Indiana, Kentucky, Missouri, Nevada, New Mexico, North Dakota, Oregon, Pennsylvania, Utah, and Washington) also are well distributed by population size and geography, and are thus assumed to be reflective of national trends. An Adjusted IRR of 0.98 for motor vehicle fatalities for Colorado 16-year-olds in 1980 means that their IRR was 98% of the average IRR for motor vehicle fatalities among 16-year-olds in the 12 "21 states" in 1980. The results are shown in Tables 1 and 2 and the process is further illustrated in Table 3.

The Adjusted IRRs for the three young age groups in the states with former drinking ages of younger than 21 in the years before, and after the state raised its drinking age to 21, were compared to the corresponding Adjusted IRRs for those same states, ages, and driver or fatality category for the years in which the drinking age was lower. The three groups of test states were

those with former drinking ages of 18; those with former graduated drinking ages of 18 for beer/wine only; and those with former drinking ages of 19 or 20. The third category was the least uniform of the three due to the mixture of drinking ages represented.

Two time periods were examined: the entire, 31-year 1975-2005 period, and a truncated, 23-year, 1975-1997 period. The latter was included to counter the argument that the post-1997 period is less reflective of the effects of changed drinking ages because (a) it is more remote in time from the finalization of the 21 drinking age in 1990, and (b) it is conflated with other law changes affecting young people such as graduated driver licensing laws, driving curfews, and similar policies affecting young people.

The changes in these Adjusted IRRs by state-year for the test states' drinking age category, driver age, and driver/fatality category from the pre-21 to post-21 years were analyzed by a standard t-test of group means. Significance levels of 0.01 or less were reported and were used in further analyses. The analyses in Tables 1 and 2 relied on comparing changes in crash and death rates by state-year, weighing small and populous states equally. A second alternative that weighed populous states more pooled the violent deaths and the population sizes of the 10 former "graduated drinking age" states and DC and the 12 "21 states" to create two large "states." These two "megastates" turned out to be reasonably similar to average state population sizes, geographic distribution, and violent death rates and changes among their respective 25-44 populations used as control series. The only difference was that during the seven-year, 1975-1981 "before" period (the maximum number of "before" years available), the first megastate maintained a graduated drinking age of 18 for beer and wine. The "after" period, 1991-97, was the first seven years after this megastate had raised its drinking age to 21. A third "megastate" was formed from pooling the violent deaths and the population sizes of the 25 states that had drinking ages of 18, 19, or 20 for all alcoholic beverages during the 1975-81 period. The Adjusted IRRs for the aggregated totals for these states were then compared to determine changes from before to after the drinking age was raised to 21.

Results

State analysis
Table 1 shows the state-by-state changes in driver involvements and violent deaths from the "before" period (when drinking ages were lower than 21) to the "after" period (when drinking ages had been raised to 21) in the 39 test states for age 18-20, the age group most affected by drinking age changes. The right-hand column of the table shows that 13 of the 20 states with former drinking ages of 18 for all alcoholic beverages experienced declines in violent deaths. These range from a significant, 23.1% decline in violent deaths in New Jersey to a 31.3% increase in Georgia, with decreases by state-year averaging 5.8%. Six of the seven driver and fatality categories showed declines, ranging from 12% for nighttime fatal crashes to no change in daytime crashes. This result is complicated by the fact that the largest states—New York, Florida, Michigan, Texas, Louisiana, and Georgia—did not experience fatality declines; in fact, the last three showed significant increases.

Similarly, five of eight states with drinking ages of 19 or 20 experienced declines in violent deaths among 18-20-year-olds, ranging from Delaware (-17.9%) to Alabama (+15.1%), with an average decline of 5.2%. None were significant. Non-significant declines occurred in five of the seven driver and fatality categories.

In contrast, all 11 states with former graduated drinking ages showed increases in violent deaths among 18-20-year-olds ranging from 3.2% in Oklahoma to 18.9% in Mississippi and 313.2% in the District of Columbia (the last excluded from the means as a radical outlier). Two states, Mississippi and South Carolina, experienced significant violent death increases. Significant increases occurred for homicide (21.2%), daytime fatal crashes (10.1%), and all violent deaths (9.5%). Six of the seven categories of driver and fatality categories showed increases.

Table 2. Changes in Adjusted Incidence Rate Ratios for fatality categories after drinking age raised to 21 by former drinking age, expanded age groups, and expanded time periods

Former drinking ages	Adjusted Incidence Rate Ratios (referent, 21 states)				n
	All crashes	Nighttime crashes	Homicides	All violent deaths	
Years 1975-2005					
Age 16-17					
Age 18, all beverages	5.7%	-3.9%	4.5%	-4.6%	117
Age 18, beer/wine only	8.6%*	-0.8%	25.8%*	7.7%*	87
Age 19, 20	2.5%	-4.6%	8.5%	-3.7%	137
Age 18-20					
Age 18, all beverages	-9.5%*	-13.8%*	-2.0%	-6.7%*	117
Age 18, beer/wine only	2.2%	-1.5%	21.4%*	8.8%*	87
Age 19, 20	-10.7%*	-13.1%*	7.2%	-8.4%*	137
Age 21-24					
Age 18, all beverages	1.0%	1.8%	11.0%	1.5%	117
Age 18, beer/wine only	1.4%	1.4%	17.8%*	7.2%*	87
Age 19, 20	-1.2%	0.4%	2.0%	-0.8%	137
Age 16-24					
Age 18, all beverages	-2.6%	-5.8%	7.5%	-2.8%	117
Age 18, beer/wine only	3.0%	-0.2%	19.9%*	7.8%*	87
Age 19, 20	-4.3%*	-5.8%*	4.8%	-4.0%*	137
Age 21, all beverages	0	0	0	0	1085
Years 1975-1997					
Age 16-17					
Age 18, all beverages	6.7%	-4.3%	12.5%	-5.8%	117
Age 18, beer/wine only	8.5%	1.5%	25.2%	5.4%	87
Age 19, 20	2.6%	-4.3%	10.1%	-5.1%	137
Age 18-20					
Age 18, all beverages	-8.3%*	-11.9%*	-0.5%	-5.8%	117
Age 18, beer/wine only	3.6%	-1.0%	21.2%*	9.5%*	87
Age 19, 20	-10.4%*	-12.6%*	6.7%	-8.5%*	137
Age 21-24					
Age 18, all beverages	-2.6%	-0.6%	7.9%	-1.2%	117
Age 18, beer/wine only	-0.5%	1.8%	11.6%	5.1%	87
Age 19, 20	-3.2%	-1.1%	-0.7%	-2.6%	137
Age 16-24					
Age 18, all beverages	-3.4%	-6.0%	7.8%	-3.8%	117
Age 18, beer/wine only	2.5%	0.5%	16.5%*	6.7%*	87
Age 19, 20	-5.0%*	-6.1%*	3.6%	-5.0%*	137
Age 21, all beverages	0	0	0	0	685

*p < 0.01.

**Age 18, 19 drinking age includes those states with former drinking ages at that level and states which had at least one year of transition at that level to the 21 drinking age. N is number of state-years.

Table 3. Changes in pooled violent death levels among young ages after drinking ages were raised to 21

	Aggregate annual deaths, populations				Violent deaths /100,000 pop.		IRR (referent: age 25-44)		Adjusted IRR (referent: IRR, 21 states)		
	Before (1975-81)		After (1991-97)								
Age	Deaths	Pop 000	Deaths	Pop 000	Before	After	Before	After	Before	After	Change
States with former drinking ages of 18, 19, or 20 for all alcoholic beverages (n=25)											
16-17	2,217	3,290.1	1,541	2,675.8	67.38	57.60	0.937	0.985	1.025	0.986	-3.8%
18-20	4,900	4,897.6	3,083	4,035.4	100.05	76.39	1.391	1.306	1.074	0.995	-7.4%
16-20	7,117	8,187.7	4,624	6,711.2	86.93	68.90	1.208	1.178	1.055	0.992	-6.0%
21-24	5,823	6,098.8	4,053	5,441.7	95.47	74.48	1.327	1.273	0.995	1.014	1.9%
16-24	12,940	14,286.5	8,677	12,152.9	90.57	71.40	1.259	1.221	1.026	1.002	-2.3%
25-44	16,311	22,676.6	18,687	31,944.9	71.93	58.50	1.000	1.000			
States with former drinking ages of 18 for beer/wine (n=11)											
16-17	1,098	1,579.6	873	1,295.0	69.51	67.42	0.912	1.081	0.998	1.082	8.4%
18-20	2,362	2,479.3	1,727	1,999.5	95.25	86.39	1.250	1.385	0.965	1.055	9.3%
16-20	3,460	4,059.0	2,601	3,294.5	85.23	78.94	1.119	1.266	0.977	1.066	9.1%
21-24	2,994	3,093.1	2,202	2,716.5	96.81	81.05	1.271	1.299	0.953	1.035	8.6%
16-24	6,454	7,152.1	4,802	6,010.9	90.24	79.89	1.184	1.281	0.965	1.051	9.0%
25-44	8,426	11,059.8	9,448	15,148.6	76.19	62.37	1.000	1.000			
States that maintained a drinking age of 21 throughout period (n=12)											
16-17	1,668	2,297.2	1,329	2,061.7	72.59	64.47	0.914	0.999	1.000	1.000	
18-20	3,641	3,538.5	2,638	3,112.9	102.89	84.73	1.295	1.313	1.000	1.000	
16-20	5,308	5,835.7	3,967	5,174.6	90.96	76.66	1.145	1.188	1.000	1.000	
21-24	4,823	4,553.0	3,439	4,241.3	105.94	81.07	1.334	1.256	1.000	1.000	
16-24	10,132	10,388.7	7,405	9,415.9	97.52	78.65	1.228	1.218	1.000	1.000	
25-44	13,188	16,601.6	15,648	24,241.1	79.44	64.55	1.000	1.000	1.000	1.000	

National analyses

Table 2 shows the effects of raising the drinking age to 21 by type of drinking age, and several age groups for both the entire 1975-2005 time period and the truncated 1975-1997 time period. The results were similar to those in Table 1. While extending the study period through 2005 might affect the individual states shown in Table 1, due to differing laws and policies that gathered momentum after 1997, there appeared to have been little effect on the groups of states in the four drinking-age categories. The effects of raising the drinking age to 21 through 2005 were similar to those evident by 1997.

Table 3 quantified the effects of raising the drinking age to 21 by comparing the pooled results for violent deaths in the 10 graduated drinking age states and DC to those of the 12 21 states from the before period (1975-81) to the after period (1991-1997). The IRRs and Adjusted IRRs displayed uniform results. First,

25-44-year-olds, those unaffected by drinking age changes, showed identical changes in violent death rates in the two sets of states from the before to the after period (down 18% in both). This indicates that secular trends other than drinking ages affecting violent deaths were similar in the two sets of states.

Second, in contrast, violent death rates declined 3% among 16-20 year-olds in the former graduated drinking-age states compared to 11% in the 21 states. Adjusted IRRs for violent deaths increased among all three young age groups in the graduated states after their drinking ages became 21. The lower rates, IRRs, and Adjusted IRRs for violent death when the drinking age was 18 for beer/wine than in the 21 states during the same period all reversed after the graduated states raised their drinking ages to 21.

The 25 states with drinking ages of 18, 19, or 20 for all alcoholic beverages in the 1975-81 period

also are shown in Table 3 (Alabama, Illinois, and Michigan had drinking ages of 21 during part of the before period, and therefore are not included). Unlike the significant declines in fatalities after these states raised their drinking ages to 21, asshown in Tables 1 and 2, the pooled results were modest and mixed; there were nonsignificant declines in violent fatalities among 16-17 and 18-20 year-olds and nonsignificant increases among those aged 21-24 years. The reason why Table 3's results differ from those of Tables 1 and 2's is that the large states that contributed most to pooled results did not experience fatality declines after raising their drinking ages to 21.

The results indicated that drinking ages for all alcoholic beverages, whether 21, 18, or in between, are associated with effects on motor vehicle crashes among those aged 18-20 years, but they have no significant positive or negative spillover effect on the adjacent age groups, 16-17 and 21-24. However, graduated drinking ages were associated with lower rates of violent death, chiefly from motor vehicle crashes and homicide, not only among 18-20-year-olds but among just-younger and just-older age groups. While the 21 drinking age was associated with reduced violent deaths among 18-20 year-olds compared to lower drinking ages for all beverages, it was associated with higher rates of violent deaths among young people compared to graduated drinking ages. The significant trends suggested that approximately 200 fewer violent deaths would have occurred per year in the 11 graduated states if they had not raised their age limits for beer and/or wine to 21.

Discussion

The expected effects of California reducing its drinking age to 18 for all alcoholic beverages are unclear and require investigation beyond this preliminary analysis. On the one hand, a large majority of states with drinking ages of 18 experienced declines in nighttime fatal crashes and most types of violent fatalities among 18-20-year-olds after raising their drinking ages to 21, a significant effect overall. However, the states most similar to California in population size and demographics such as Texas, New York, and Florida, generally did not benefit from raising their drinking ages from 18 to 21. If California's experience is projected to be similar to that of other populous states, there may be less risk in adopting a drinking age of 18 than the experiences of most states with drinking ages of 18 would indicate.

Adopting a drinking age of 18 for beer and wine only may provide the most feasible and moderate option. These graduated drinking ages are associated with significantly lower violent fatality rates among 18-20-year-olds and also among ages 16-17 and 21-24. This latter finding is particularly striking both in the strength of its statistical significance and the fact that all 10 states and DC with graduated drinking ages suffered increased fatal crashes and violent deaths among a broad spectrum of young ages after raising their drinking ages to 21 for all alcoholic beverages.

One source of the significant increase in violent deaths in this case is homicide. Six states and DC experienced significant increases in homicide deaths among 18-20-year-olds after raising drinking ages to 21. This is an unexpected finding, since several of the "21 states" to which they were compared against—California, Pennsylvania, and Missouri, among others—themselves experienced sharp increases in homicide among young age groups during the same periods, making the significantly larger murder increases in states that raised their drinking ages even more striking. Although the mechanism is unclear, it should be noted that large increases in homicide also accompanied general alcohol Prohibition in the 1920s. Plausible explanations for the homicide increase after drinking ages were raised to 21 may relate to the transfer of drinking venues to unregulated, clandestine settings promoting heavier alcohol use (see Newes-Adeyi, et al., 2007; Hughes & Dodder, 1992) and, more speculatively, to increased unemployment among poorer urban young people banned from entry-level jobs related to distributing and selling alcohol. Raising a graduated drinking age to 21 also is associated with small, nonsignificant increases in fatal crashes, motor vehicle and other accidents, and suicide.

A more consistent finding suggests that if California reduced its legal drinking age to 18 for beer and wine only, violent deaths among 18-20 year-olds could possibly be reduced by approximately 9%, or approximately90 per year based on 2005 totals (Center for Health Statistics, 2008). Nearly all of this decrease would be from reduced fatal motor vehicle crashes and homicides. The findings from other states also suggest significantly reduced violent deaths among ages 16-17 and 21-24 might occur as a result of the policy change.

The suggestion that making beer and wine legally available to 18-20-year-olds holds the potential to reduce violent deaths in that age group and possibly surrounding age groupsseems counterintuitive, and there are complications. This type of graduated drinking age is associated with a "system" that signifies a different way of viewing the socialization of young people into alcohol use. Most of these states had maintained graduated drinking ages for decades and consequently had developed unique systems of low-alcohol "3.2 bars" and sectioned-off areas of regular bars providing separate venues for young people to drink low-alcohol beverages apart from older drinkers, socialize, patronize entertainment, and find entry level employment. Fixed drinking ages for all alcoholic beverages, whether 18 or 21 or in between, effectively abolished the "3.2 bars" and may have contributed to the more hazardous drinking environments for 18-20-year-olds both in states with low and high drinking ages.

Thus, the recommendation that California reduce its drinking age for beer and wine to 18

necessarily includes careful study of the feasibility of adopting the low-alcohol bar system associated with the lower rates of risk in states that formerly had graduated age limits. The risks of adopting a graduated drinking age also must be weighed against the risks of maintaining California's current 21 drinking age that, despite the arrests of 300 young Californians per week for alcohol possession, continues to accompany high and resurgent rates of drunken driving and alcohol poisoning fatality among both current young residents and older residents who grew up under the prevailing alcohol regulation system.

Limitations of study
The unique demographics of California, its long history with a drinking age of 21, and the large number of potential confounders make precise prediction of alcohol-related outcomes difficult. One potential limitation is that this study's analysis of the effects of raised drinking ages may not predict, in mirror image, the effects of lowering drinking ages. Second, there are additional analytical techniques such as seasonally-adjusted moving averages, alternative control series and time periods, and other measures of alcohol-related outcomes that can yield information from multiple reference points to supplement theincidence rate analysis performed in this study. Finally, better understanding of the mechanisms underlying young people's lower rates of traffic fatalities, other fatal accidents, and homicides in states that formerly implemented graduated drinking ages is necessary to understanding any potential benefits of policy change in California.

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Appendix A

Table 1. States ranked by former drinking age and changes in violent deaths for age 18-20 following raising their drinking ages to 21, 1975-1997

State, year 21 drinking age began	Change in Adjusted Incidence Rate Ratio (referent: 21 states**) for							
	Driver involvements in fatal motor vehicle crashes			Fatalities from				
				motor vehicle	other			all violent
	all	night**	day**	accident	accident	suicide	homicide	causes
Former drinking age of 18, all beverages								
NJ, 1985	-13.2%	-16.9%	3.0%	-30.7%*	-16.5%	-27.7%	11.6%	-23.1%*
NH, 1987	-31.6%	-36.0%	-19.0%	-25.5%	-28.6%	-0.3%	-72.0%	-20.8%
CT, 1987	-22.2%	-19.9%	-20.7%	-24.8%	-23.2%	-23.5%	70.3%*	-18.5%
MT, 1990	4.2%	-7.3%	17.6%	-2.0%	24.0%	-27.8%	-64.7%	-17.2%
MN, 1989	-10.9%	-25.6%	8.9%	-15.1%	13.1%	-11.0%	-36.9%	-15.2%
IA, 1989	-10.7%	-24.5%	4.9%	-11.6%	-12.9%	3.2%	-19.0%	-15.1%
VT, 1990	5.2%	0.7%	10.0%	-7.4%	21.6%	-7.5%	-86.3%	-14.0%
MA, 1987	-17.4%*	-7.4%	-18.8%*	-11.2%	0.3%	-20.6%	66.9%*	-13.7%
WI, 1989	-27.5%*	-32.1%*	-13.6%	-21.1%	-5.0%	-6.1%	34.5%	-11.3%
HI, 1987	-2.6%	-3.3%	10.1%	-1.1%	-20.1%	-17.3%	-3.3%	-11.0%
RI, 1985	-17.7%	-22.4%	-4.4%	-16.9%	7.9%	5.3%	49.6%	-9.8%
WV, 1989	-9.5%	-28.7%*	6.4%	-10.2%	2.6%	0.7%	-16.7%	-6.9%
ME, 1987	-1.7%	-0.1%	2.8%	0.2%	28.0%	-13.2%	-12.6%	-5.4%
TN, 1987	6.3%	0.4%	11.4%	-6.3%	-1.8%	-4.5%	16.3%	2.5%
MI, 1979	-9.2%	-12.9%	-1.9%	-18.5%	4.6%	-11.8%	30.1%	2.7%
NY, 1986	-10.2%*	-15.0%*	3.6%	-16.9%*	-28.5%*	8.3%	26.7%	5.8%
FL, 1987	5.0%	-0.8%	12.2%	-7.3%	-1.2%	-4.6%	22.9%	9.8%
TX, 1987	-2.9%	-4.9%	-3.0%	-1.0%	8.3%	3.2%	18.9%	10.4%*
LA, 1991	-9.2%	-4.4%	-19.5%	-8.9%	7.5%	17.3%	31.7%	24.5%*
GA, 1987	6.4%	4.2%	9.9%	2.1%	38.0%*	52.1%*	50.2%*	31.3%*
Average**	-8.3%*	-11.9%*	0.0%	-11.5%*	-1.7%	-7.0%	-0.5%	-5.8%
Former graduated drinking age of 18, beer and wine only								
OK, 1984	3.7%	4.4%	2.3%	3.9%	13.6%	-0.3%	0.8%	3.2%
OH, 1990	-7.3%	-11.2%	0.6%	0.5%	-3.8%	7.7%	7.3%	7.1%
MD, 1986	2.6%	8.4%	1.7%	-4.2%	12.8%	-41.3%	65.2%*	7.4%
KS, 1989	-1.5%	-9.7%	13.2%	3.0%	6.2%	10.2%	31.0%	8.8%
SD, 1991	-7.2%	-9.4%	3.2%	-6.3%	36.9%	54.9%	-39.9%	8.8%
CO, 1991	10.2%	7.7%	15.2%	18.2%	-6.7%	12.3%	19.9%	9.2%
NC, 1987	2.4%	-4.3%	10.9%	-5.6%	25.6%	7.4%	30.3%	12.0%
VA, 1988	-3.1%	-5.0%	1.0%	-3.6%	-3.7%	9.8%	66.0%*	12.2%
SC, 1987	23.5%*	13.5%	30.9%*	22.1%	4.8%	-13.8%	34.0%	17.7%*
MS, 1987	13.8%	7.8%	17.8%	8.4%	33.1%	7.6%	9.1%	18.9%*
DC, 1990**	103.8%	140.7%	64.0%	27.0%	47.2%	143.7%	185.0%*	313.2%*
Average**	3.6%	-1.0%	10.1%*	3.4%	10.1%	2.7%	21.2%*	9.5%*
Former drinking age of 19 or 20**								
DE, 1985	-6.5%	-6.7%	-13.7%	-17.6%	-14.5%	-40.3%	-3.1%	-17.9%
AK, 1986	-21.4%	-22.3%	-7.4%	-25.8%	27.4%	-18.4%	-22.4%	-10.9%
ID, 1990	-20.0%	-33.3%*	-10.0%	-11.9%	27.9%	-8.8%	15.7%	-8.9%
NE, 1986	-3.3%	-5.7%	-0.1%	-13.5%	6.2%	28.2%	-3.9%	-7.3%

AZ, 1987	-1.8%	-0.1%	-0.6%	-7.0%	-7.5%	6.2%	8.3%	-2.5%
WY, 1989	-0.1%	1.3%	2.5%	9.4%	22.1%	-6.6%	24.2%	1.5%
IL, 1980	-6.4%	-8.7%	-0.7%	-14.1%	-23.3%	-3.8%	26.1%	2.7%
AL, 1987	7.4%	0.5%	12.1%	1.1%	17.3%	2.3%	39.5%*	15.1%
Average**	-7.5%	-8.8%	-5.8%	-10.4%	3.9%	-8.9%	17.2%	-5.2%
Drinking age of 21 for all beverages throughout period (referent)								
Average**	0	0	0	0	0	0	0	0

*p < 0.01.
**Average for graduated drinking age states excludes DC. Fatal crash involvements, night, are those occurring from 8pm to 3:59am; day is all other. For ICD codes used for fatality categories, see Method. Drinking age of 19, 20 includes only those states with former drinking ages at that level, not states in transition to the 21 drinking age. Illinois drinking age was for beer only. Adjusted Incidence Rate Ratio (IRR) is the Adjusted IRR for states with former drinking ages of less than 21 to the adjusted IRR of the "21 states" that maintained a drinking age of 21 throughout the 1975-1997 period. The adjusted IRR for each state is the ratio of fatality or driver involvement rates for age 18-20 to those of age 25-44 for that state, fatality/driver category, and year. Averages are for state-years, not states.